CHAPTER 5

LESSON 5.1

EXERCISES

1. a. $(-15.6, 0.2)$ is a solution because $47 + 3(-15.6) = 0.2$ and $8 + 0.5(-15.6) = 0.2$.

b. $(-4, 23)$ is not a solution because $23 \neq 12 + (-4)$.

c. $(2, 12.3)$ is not a solution because $12.3 \neq 4.5 + 5(2)$. You can also tell that the ordered pair is not a solution because the equations represent parallel lines, which never intersect.

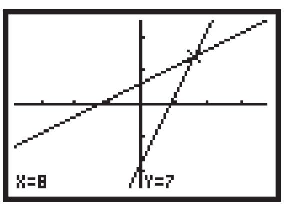
2. a. For one of the lines, the y-values increase as the x-values increase. For the other line, the y-values decrease as the x-values increase. Only table iv fits these conditions.

b. For both lines, the y-values increase as the x-values increase. Only table iii fits these conditions.

c. One of the lines is horizontal, so the y-values are constant. Only table i fits these conditions.

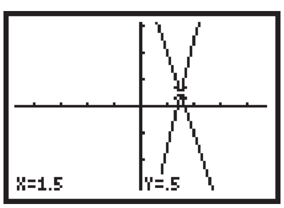
d. For both lines, the y-values decrease as the x-values increase. Only table ii fits these conditions.

3. a. $(8, 7)$. This is an exact solution because it satisfies both equations.



$[-18.8, 18.8, 5, -12.4, 12.4, 5]$

b. $(1.5, 0.5)$. This is an exact solution because it satisfies both equations.



$[-4.7, 4.7, 1, -3.1, 3.1, 1]$

4. a. $(3.4, 15.5)$

X	Y1	Y2
3	14.5	17.9
3.1	14.75	17.3
3.2	15	16.7
3.3	15.25	16.1
3.4	15.5	15.5
3.5	15.75	14.9
3.6	16	14.3

X=3.4

b. $(7.3, -5.6)$

X	Y1	Y2
7	-5	-4.7
7.1	-5.2	-5
7.2	-5.4	-5.3
7.3	-5.6	-5.6
7.4	-5.8	-5.9
7.5	-6	-6.2
7.6	-6.2	-6.5

X=7.3

5. a. $y = 3 - 2x$. Substituting 1 for x gives $y = 3 - 2(1) = 1$. Substituting $(1, 1)$ into the original equation gives $4(1) + 2(1) = 6$. So, $(1, 1)$ satisfies both forms of the equation.

b. $y = -4 + 0.4x$. Substituting 1 for x gives $y = -4 + 0.4(1) = -3.6$. Substituting $(1, -3.6)$ into the original equation gives $2(1) - 5(-3.6) = 20$. So, $(1, -3.6)$ satisfies both forms of the equation.

6. a. Let P represent profit in dollars, and let N represent the number of "hits." Profit is income minus expenses. The income is the \$2.50 per "hit," and the expenses are the \$12,000 spent on setup and supplies. So, the equation for profit is $P = 2.5N - 12{,}000$, or $P = -12{,}000 + 2.5N$.

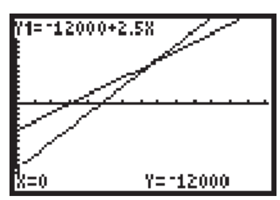
b. P represents profit in dollars, and N represents the number of "hits" to the website. \$5,000 is Widget.kom's start-up cost, and \$1.60 is the amount its advertisers pay per hit. Because Widget.kom spent less in start-up costs, its website might be less attractive to advertisers, hence the lower rate.

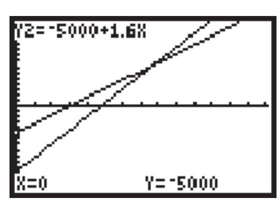
c. When $N = 7778$, $P \approx 7445$ in both equations.

X	Y1	Y2
7775	7437.5	7440
7776	7440	7441.6
7777	7442.5	7443.2
7778	7445	7444.8
7779	7447.5	7446.4
7780	7450	7448
7781	7452.5	7449.6

X=7778

d. Graphing windows will vary. The graphs below are in the window $[0, 14100, 1000, -15000, 15000, 6000]$.



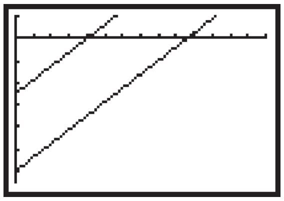


e. The intersection point is about (7778, 7445). This point can be found from the table. The point is fairly accurate. Substituting 7778 for N gives a P-value of 7445 in one equation and of 7444.8 in the other. These P-values are very close to each other.

f. The coordinates of the intersection point indicate that for 7778 hits, both companies make a profit of about $7,445.

7. a. $P = -5000 + 2.5N$

b.



$[0, 7000, 500, -13000, 2000, 2000]$

c. The line for Sally's company (Gadget.kom) is parallel to and above the line for Gizmo.kom, indicating that Gadget.kom will always profit more than Gizmo.kom from the same number of hits.

d. To find the x-intercept, solve the equation $0 = -5000 + 2.5N$ to obtain $N = 2000$. This solution means that Sally will break even at 2000 hits, and after 2000 hits, Sally will have earned back her start-up cost.

8. a. The rate of change for University College is $30 per credit hour. The tuition for 1 credit is $55, so the fixed fees must be 55 − 30, or $25. So the equation for University College is $y = 25 + 30x$, where x is the number of credits and y is the tuition.

The rate of change for State College is $32 per credit hour. The tuition for 1 credit is $47, so the fixed fees must be 47 − 32, or $15. So, the equation for State College is $y = 15 + 32x$, where x is the number of credits and y is the tuition. The system is

$$\begin{cases} y = 25 + 30x \\ y = 15 + 32x \end{cases}$$

b. (5, 175). Check: $175 = 25 + 30(5)$, $175 = 15 + 32(5)$.

c. Answers will vary.

d. When a student takes 5 credit hours, the tuition at either college is $175.

e. For more than 5 credits, it is cheaper to attend University. For fewer than 5 credits, it is cheaper to attend State. For 5 credits, they cost the same.

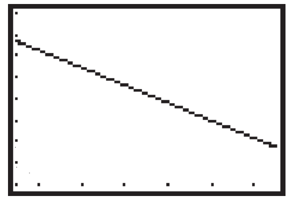
9. a. $$\begin{cases} d = 9 - t & \text{Drill team member's distance from 0 yd mark} \\ d = 3 + 0.5t & \text{Tuba player's distance from 0 yd mark} \end{cases}$$

b. (4, 5). After 4 s, the tuba player bumps into the drill team member at the 5 yd mark.

10. a. The equations give winning times of 28.239 min and 28.2398 min. The difference is 0.0008.

b. The equations give winning times of 26.7594 min and 26.7602 min. The difference is 0.0008.

c.



$[1945, 2005, 10, 26, 30, 0.5]$

d. $$\begin{cases} y = 109.2882 - 0.0411x \\ y = 109.289 - 0.0411x \end{cases}$$

The graph in 10c appears to show one line. However, the y-values are 0.0008 unit apart. Even though the two lines are not identical, they are well within the accuracy of the model, so you could say they represent the same model.

11. a. To have exactly one solution, the lines need to have different slopes, so b can have any value except −5, and a can have any value.

b. To have no solutions, the lines must be parallel—that is, they must have the same slope—but they must have different y-intercepts. So, b must be −5 and a can have any value but 2.

c. To have infinitely many solutions, the lines must be identical, so $a = 2$ and $b = -5$.

12. All answers are calculated using previous answers stored as unrounded values, and given with three- or four-place accuracy. Answers will vary slightly if intermediate rounding is used.

a. The length of a 5-lap race is 5(2.5 mi) = 12.5 mi.

Spirit of the Tri-Cities:

$$t = \frac{d}{r} = \frac{12.5 \text{ mi}}{145.000 \text{ mi/h}} \approx 0.0862 \text{ h}$$

Convert this time to minutes:

$$0.0862 \text{ h} \cdot \frac{60 \text{ min}}{1 \text{ h}} \approx 5.172 \text{ min.}$$

Miss B:

$$t = \frac{d}{r} = \frac{12.5 \text{ mi}}{163.162 \text{ mi/h}} \approx 0.0766 \text{ h}$$

Convert this time to minutes:

$$0.0766 \text{ h} \cdot \frac{60 \text{ min}}{1 \text{ h}} \approx 4.597 \text{ min.}$$

b. *Spirit of the Tri-Cities:* $5.172 \text{ min} \cdot \frac{4.3 \text{ gal}}{\text{min}} \approx$ 22.241 gal, using stored, unrounded values

Miss B: $4.597 \text{ min} \cdot \frac{4.3 \text{ gal}}{\text{min}} \approx$ 19.766 gal, using stored, unrounded values

c. Use proportions to calculate the number of miles that each hydroplane can go on 43 gal of fuel.

Spirit of the Tri-Cities: $\frac{12.5 \text{ mi}}{22.241 \text{ gal}} = \frac{x \text{ mi}}{43 \text{ gal}}$; $x \approx 24.167$. Or, because the hydroplane uses 4.3 gal/min, it can go 10 min on 43 gal. So, it can go 10 min $\cdot \frac{145.000 \text{ mi}}{1 \text{ h}} \cdot \frac{1 \text{ h}}{60 \text{ min}} \approx$ 24.167 mi on one tank of fuel.

Miss B: $\frac{12.5 \text{ mi}}{19.766 \text{ gal}} = \frac{x \text{ mi}}{43 \text{ gal}}$; $x \approx 27.194$, using stored, unrounded values. Or, in 10 min it can go 10 min $\cdot \frac{163.162 \text{ mi}}{1 \text{ h}} \cdot \frac{1 \text{ h}}{60 \text{ min}} \approx 27.194$ mi on one tank of fuel.

d. *Spirit of the Tri-Cities:* $\frac{12.5 \text{ mi}}{22.241 \text{ gal}} \approx 0.562$ mpg. Or, using dimensional analysis, $\frac{145.000 \text{ mi}}{1 \text{ h}} \cdot \frac{1 \text{ min}}{4.3 \text{ gal}} \cdot \frac{1 \text{ h}}{60 \text{ min}} \approx 0.562$ mpg.

Miss B: $\frac{12.5 \text{ mi}}{19.766 \text{ gal}} \approx 0.632$ mpg. Or, using dimensional analysis, $\frac{163.162 \text{ mi}}{1 \text{ h}} \cdot \frac{1 \text{ min}}{4.3 \text{ gal}} \cdot \frac{1 \text{ h}}{60 \text{ min}} \approx$ 0.632 mpg.

13. In 13a–e, other methods may be used.

a.

$0.75x = 63.75$	Original equation.
$\frac{0.75x}{0.75} = \frac{63.75}{0.75}$	Divide both sides by 0.75.
$x = 85$	

Check: $0.75(85) = 63.75$

b.

$18.86 = -2.3x$	Original equation.
$\frac{18.86}{-2.3} = \frac{-2.3x}{-2.3}$	Divide both sides by -2.3.
$-8.2 = x$, or $x = -8.2$	

Check: $18.86 = -2.3(-8.2)$

c.

$6 = 12 - 2x$	Original equation.
$2x + 6 = 12$	Add $2x$ to both sides.
$2x = 6$	Subtract 6 from both sides.
$x = 3$	Divide both sides by 2.

Check: $6 \stackrel{?}{=} 12 - 2(3)$; $6 \stackrel{?}{=} 12 - 6$; $6 = 6$

d.

$9 = 6(x - 2)$	Original equation.
$9 = 6x - 12$	Distributive property.
$21 = 6x$	Add 12 to both sides.
$x = \frac{21}{6} = \frac{7}{2}$, or 3.5	

Check: $9 \stackrel{?}{=} 6(3.5 - 2)$; $9 \stackrel{?}{=} 6(1.5)$; $9 = 9$

e.

$4(x + 5) - 8 = 18$	Original equation.
$4x + 20 - 8 = 18$	Distributive property.
$4x + 12 = 18$	Combine like terms.
$4x = 6$	Subtract 12 from both sides.
$x = \frac{6}{4} = \frac{3}{2}$, or 1.5	

Check: $4(1.5 + 5) - 8 \stackrel{?}{=} 18$; $4(6.5) - 8 \stackrel{?}{=} 18$; $26 - 8 \stackrel{?}{=} 18$; $18 = 18$

14. The balance represents the equation $2x + 9 = 6x + 1$.

$2x + 9 = 6x + 1$	Original equation.
$2x - 2x + 9 = 6x - 2x + 1$	Subtract $2x$ from both sides.
$9 = 4x + 1$	Combine like terms.
$9 - 1 = 4x + 1 - 1$	Subtract 1 from both sides.
$8 = 4x$	Combine like terms.
$\frac{8}{4} = \frac{4x}{4}$	Divide both sides by 4.
$x = 2$	Reduce.

15. a. $\begin{bmatrix} 1 & -11 \\ -6 & 8 \end{bmatrix}$

b. $\begin{bmatrix} 13 & -1 \\ 7 & 8 \end{bmatrix}$

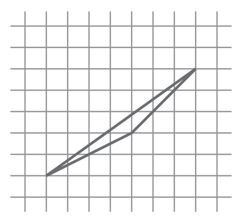
16. a. $y = 5x - 2$

b. $y = 0.8 - 1.4x$

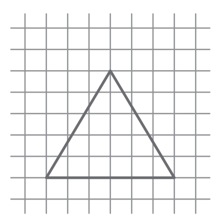
c. $y = 1.5 + 3x$

Improving Your Geometry Skills

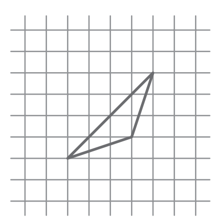
1.



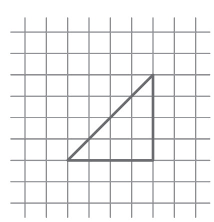
2.



3.



4.



5. This is not possible; the sides would be parallel and therefore would never meet. The sides of a triangle must meet at a vertex.

LESSON 5.2

EXERCISES

1. Stage 3: Add $2.5t$ to both sides. Stage 5: Divide both sides by 4.

2. a. $(-2, 34)$ is not a solution because it satisfies only the first equation.

b. $(4.25, 19.25)$ is a solution because $19.25 = 32 - 3(4.25)$ and $19.25 = 15 + 4.25$.

c. $(2, 12.3)$ is not a solution because it satisfies only the second equation. You can also tell that the ordered pair is not a solution because the equations represent parallel lines, which never intersect.

3. Solution steps will vary. Sample solutions are given.

a.

$14 + 2x = 4 - 3x$	Original equation.
$14 + 5x = 4$	Add $3x$ to both sides.
$5x = -10$	Subtract 14 from both sides.
$x = -2$	Divide both sides by 5.

b.

$7 - 2y = -3 - y$	Original equation.
$7 - y = -3$	Add y to both sides.
$-y = -10$	Subtract 7 from both sides.
$y = 10$	Multiply both sides by -1.

c.

$5d = 9 + 2d$	Original equation.
$3d = 9$	Subtract $2d$ from both sides.
$d = 3$	Divide both sides by 3.

d.

$12 + t = 4t$	Original equation.
$12 = 3t$	Subtract t from both sides.
$4 = t$	Divide both sides by 3.

4. Solution steps will vary. A sample solution is given.

$y = 25 + 30x$	Original first equation.
$15 + 32x = 25 + 30x$	Substitute $15 + 32x$ (from the second equation) for y.
$15 + 2x = 25$	Subtract $30x$ from both sides.
$2x = 10$	Subtract 15 from both sides.
$x = 5$	Divide both sides by 5.

To find y, substitute 5 for x in either equation: $y = 25 + 30(5) = 175$. The solution is $(5, 175)$. Check: $175 = 25 + 30(5)$, $175 = 15 + 32(5)$.

5. a. $5x + 2(4 - 3x) = 5x + 8 - 6x = -x + 8$

b. $7x - 2(4 - 3x) = 7x - 8 + 6x = 13x - 8$

6. Solution steps will vary. Sample solutions are given.

a.

$y = 4 - 3x$	Original first equation.
$2x - 1 = 4 - 3x$	Substitute $2x - 1$ (from the second equation) for y.
$-1 = 4 - 5x$	Subtract $2x$ from both sides.
$-5 = -5x$	Subtract 4 from both sides.
$1 = x$	Divide both sides by -1.

To find y, substitute 1 for x in either equation: $y = 4 - 3(1) = 1$. The solution is $(1, 1)$. Check: $1 = 4 - 3(1)$, $1 = 2(1) - 1$.

b. Solve the second equation for x: $x = 1 - 3y$. Now substitute $1 - 3y$ for x in the first equation and solve for y.

$2x - 2y = 4$	Original first equation.
$2(1 - 3y) - 2y = 4$	Substitute $1 - 3y$ for x.
$2 - 6y - 2y = 4$	Apply the distributive property.
$2 - 8y = 4$	Combine $-6y$ and $-2y$.
$-8y = 2$	Subtract 2 from both sides.
$y = -\frac{1}{4}$	Divide both sides by -8.

To find x, substitute $-\frac{1}{4}$ for y in either equation: $x + 3\left(-\frac{1}{4}\right) = 1$, so $x = 1 + \frac{3}{4} = \frac{7}{4}$. Check: $2(1.75) - 2(-0.25) = 4$, $1.75 + 3(-0.25) = 1$.

7. a. Solution steps will vary. A sample solution is given.

$P = -5{,}000 + 1.6N$	Original second equation.
$-12{,}000 + 2.5N = -5{,}000 + 1.6N$	Substitute $-12{,}000 + 2.5N$ for P.
$-12{,}000 + 0.9N = -5{,}000$	Subtract $1.6N$ from both sides.
$0.9N = 7{,}000$	Add 12,000 to both sides.
$N = \frac{70{,}000}{9} = 7{,}777\frac{7}{9}$	Multiply both sides by 10 and then divide both sides by 9.

To find P, substitute $\frac{70{,}000}{9}$ for N in either equation:

$$P = -12{,}000 + 2.5\left(\frac{70{,}000}{9}\right) = 7{,}444\frac{4}{9}$$

b. The approximate solution, $N \approx 7778$ and $P \approx 7445$, is more meaningful because it is not possible to have a fractional number of website hits.

8. a. The first equation states that the total admission price for two adults and three students is \$13.50.

b. $\begin{cases} 2x + 3y = 13.50 \\ 3x + 2y = 16.50 \end{cases}$

First, solve the first equation for y.

$$2x + 3y = 13.50$$
$$2x + 3y - 2x = 13.50 - 2x$$
$$3y = 13.50 - 2x$$
$$\frac{3y}{3} = \frac{13.50 - 2x}{3}$$
$$y = \frac{13.50 - 2x}{3}$$

Substitute $\frac{13.50 - 2x}{3}$ for y in the second equation, and solve for x.

$$\begin{aligned}
3x + 2y &= 16.50\\
3x + 2\left(\frac{13.50 - 2x}{3}\right) &= 16.50\\
3x + \frac{2(13.50 - 2x)}{3} &= 16.50\\
\frac{9x}{3} + \frac{27 - 4x}{3} &= 16.50\\
\frac{9x + 27 - 4x}{3} &= 16.50\\
\frac{5x + 27}{3} &= 16.50\\
5x + 27 &= 49.50\\
5x &= 22.5\\
x &= 4.5
\end{aligned}$$

To find the corresponding y-value, substitute 4.5 for x in one of the two original equations.

$$\begin{aligned}
2x + 3y &= 13.50\\
2(4.5) + 3y &= 13.50\\
9 + 3y &= 13.50\\
3y &= 4.50\\
y &= 1.5
\end{aligned}$$

c. An adult ticket costs \$4.50, and a student ticket costs \$1.50.

9. a. $A + C = 200$ **b.** $8A + 4C = 1304$

c. The system is $\begin{cases} A + C = 200 \\ 8A + 4C = 1304 \end{cases}$. To solve this system, you could rewrite the first equation as $A = 200 - C$, and then substitute $200 - C$ for A in the second equation and solve for C. The solution to the system is $A = 126$ and $C = 74$. The theater sold 126 adult tickets and 74 child tickets.

10. a. The first walker starts at the 0.5 m mark and walks away at 0.75 m/s. The second walker starts at the 2.5 m mark and walks away at 0.75 m/s.

b. Both equations are already solved for d. Substitute $2.5 + 0.75t$ for d in the first equation.

$$2.5 + 0.75t = 0.5 + 0.75t$$

$$2.5 + 0.75t - 0.75t = 0.5 + 0.75t - 0.75t \quad \text{Subtract } 0.75t \text{ from both sides.}$$

$$2.5 = 0.5 \quad \text{Combine like terms.}$$

This false result indicates that the original system has no solution.

c. This means that the walkers will never meet.

11. a. $\begin{cases} d = 35 + 0.8t \\ d = 1.1t \end{cases}$; $t = 116\frac{2}{3}$, $d = 128\frac{1}{3}$. The pickup passes the sports car roughly 128 miles from Flint after approximately 117 minutes.

b. $\begin{cases} d = 220 - 1.2t \\ d = 1.1t \end{cases}$; $t \approx 95.7$, $d \approx 105.2$. The minivan meets the pickup truck about 105 miles from Flint after approximately 96 minutes.

c. $\begin{cases} d = 220 - 1.2t \\ d = 35 + 0.8t \end{cases}$; $t = 92.5$, $d = 109$. The minivan meets the sports car 109 miles from Flint after 92.5 minutes.

d. $220 - 1.2t = 2(35 + 0.8t)$; $t \approx 53.6$ min. The minivan is twice as far from Flint after about 53.6 minutes. At that time, the minivan is about 156 miles from Flint, and the sports car is about 78 miles from Flint.

12. a. Women:

The Q-points are (1976, 71.16) and (1996, 67.73).

This gives a slope of $\frac{67.73 - 71.16}{1996 - 1976} = \frac{-3.43}{20} = -0.1715$.

Line of fit: $y = 71.16 - 0.1715(x - 1976)$ or $y = 67.73 - 0.1715(x - 1996)$

Men:

The Q-points are (1976, 63.44) and (1996, 60.60).

This gives a slope of $\frac{60.60 - 63.44}{1996 - 1976} = \frac{-2.84}{20} = -0.142$.

Line of fit: $y = 63.44 - 0.142(x - 1976)$ or $y = 60.60 - 0.142(x - 1996)$

b. Form a system of equations from the first of each pair of equations given above for women and men:

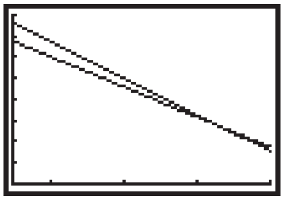
$$\begin{cases} y = 71.16 - 0.1715(x - 1976) \\ y = 63.44 - 0.142(x - 1976) \end{cases}$$

To solve this system by substitution, substitute $63.44 - 0.142(x - 1976)$ for y in the first equation, and solve for x.

$$\begin{aligned}
63.44 - 0.142(x - 1976) &= 71.16 - 0.1715(x - 1976)\\
63.44 - 0.142x + 280.592 &= 71.16 - 0.1715x + 338.884\\
344.032 - 0.142x &= 410.044 - 0.1715x\\
0.0295x + 344.032 &= 410.044\\
0.0295x &= 66.012\\
x &\approx 2238
\end{aligned}$$

Now, substitute 2238 for x in either of the original equations of the system, and solve for y.

$$\begin{aligned}
y &= 71.16 - 0.1715(x - 1976)\\
y &= 71.16 - 0.1715(2238 - 1976)\\
y &\approx 26.23
\end{aligned}$$

c. 

[1950, 2300, 100, 0, 80, 10]

d. The solution means that in the year 2238 (more than 200 years from now), both men and women will swim this race in 26.23 s. This is not likely. The model might be a good fit for the data, but extrapolating that far in the future produces predictions that are unlikely to come true.

13. Let $x =$ the number of pounds of sour cherry worms, and let $y =$ the number of pounds of sour lime bugs.

The total amount of candy in the mix is to be 20 lb, so $x + y = 20$.

The store manager's total cost of the mix is to be \$65, so $2.50x + 3.50y = 65$.

Therefore, a system of equations that models this problem is

$$\begin{cases} x + y = 20 \\ 2.50x + 3.50y = 65 \end{cases}$$

To solve this system by the substitution method, first solve the first equation for y. (You could just as easily solve it for x.)

$y = 20 - x$

Substitute $20 - x$ for y in the second equation, and solve for x.

$$\begin{aligned} 2.50x + 3.50(20 - x) &= 65 \\ 2.50x + 70 - 3.50x &= 65 \\ -x + 70 &= 65 \\ -x &= -5 \\ x &= 5 \end{aligned}$$

Now substitute 5 for x in the first original equation, and solve for y.

$$\begin{aligned} x + y &= 20 \\ 5 + y &= 20 \\ y &= 15 \end{aligned}$$

The manager should include 5 lb of sour cherry worms and 15 lb of sour lime bugs in the mix.

14. f represents liters of fruit juice, s represents liters of soda

$$\begin{cases} f + s = 10 \\ 0.65f + 0.05s = 0.33(10) \end{cases}$$

$f = 4\frac{2}{3}$, $s = 5\frac{1}{3}$; $4\frac{2}{3}$ L of bottled fruit juice and $5\frac{1}{3}$ L of natural orange soda

15. a. Every point on a horizontal line has the same y-coordinate, so the equation of a horizontal line through $(3, -4.5)$ is $y = -4.5$.

b. Every point on a vertical line has the same x-coordinate, so the equation of a vertical line through $(3, -4.5)$ is $x = 3$.

16. a. $\frac{520 \text{ ft}}{43 \text{ s}} \approx 12.1$ ft/s

b. $605 \text{ ft} \cdot \frac{1 \text{ s}}{12.1 \text{ ft}} \approx 50$ s

c. The initial height of the elevator is 100 ft and the elevator travels at 12.1 ft/s, so the equation for the height, y, after x seconds is $y = 100 + 12.1x$. To find the number of seconds it will take to get to the observation deck, solve the equation $520 = 100 + 12.1x$.

17. a. $2\frac{1}{6}$ **b.** $\frac{2}{3}$

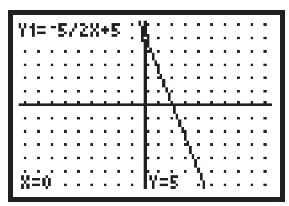
c. $\frac{1}{6}$ **d.** $\frac{97}{60}$, or $1\frac{37}{60}$

18. a. i **b.** iii **c.** ii

LESSON 5.3

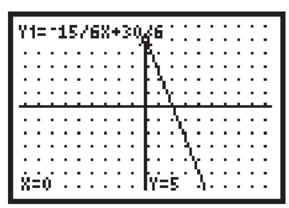
EXERCISES

1. a. $y = \frac{10 - 5x}{2}$, or $y = \frac{10}{2} - \frac{5}{2}x = 5 - \frac{5}{2}x$



[−9.4, 9.4, 1, −6.2, 6.2, 1]

b. $y = \frac{30 - 15x}{6}$, or $y = \frac{30}{6} - \frac{15}{6}x = 5 - \frac{5}{2}x$



The graphs are the same because multiplying both sides of an equation by the same number results in an equivalent equation.

2. a. Substitute 6 for x and a for y and solve for a.

$$\begin{aligned} 5(6) - 2a &= 10 \\ 30 - 2a &= 10 \\ -2a &= -20 \\ a &= 10 \end{aligned}$$

b. Substitute -4 for x and b for y and solve for b.

$$5(-4) - 2b = 10$$
$$-20 - 2b = 10$$
$$-2b = 30$$
$$b = -15$$

c. Substitute 25 for y and c for x and solve for c.

$$5c - 2(25) = 10$$
$$5c - 50 = 10$$
$$5c = 60$$
$$c = 12$$

d. Substitute -5 for y and d for x and solve for d.

$$5d - 2(-5) = 10$$
$$5d + 10 = 10$$
$$5d = 0$$
$$d = 0$$

3. a. Add the equations to eliminate x. You get $-5y = 5$, so $y = -1$. To find x, you can substitute -1 for y in either equation and solve for x. The result is $x = -\frac{5}{2}$, or -2.5. So, the solution is $(-2.5, -1)$.

b. You can eliminate y by multiplying the first equation by 2 and adding it to the second equation.

$$\begin{array}{rl} 10x - 8y = 46 & \\ \underline{7x + 8y = 5} & \\ 17x = 51 & \text{Add the equations.} \\ x = 3 & \text{Divide by 17.} \end{array}$$

So $x = 3$. To find y, substitute 3 for x in either equation and solve for y. The result is $y = -2$. So the solution is $(3, -2)$.

4. a. Substitution

b. Her solution is not complete. Although she correctly found the value of x, she did not substitute it into one of the original equations to find the value of y.

c. Substitute 4 for x in either of the two equations of the original system. In this case, it is easier to use the first equation.

$y = x - 5$

$y = 4 - 5 = -1$

The system has one solution, $(4, -1)$.

5. a. Multiply the first equation by -5 and the second equation by 3, or multiply the first equation by 5 and the second equation by -3.

b. Multiply the first equation by -8 and the second equation by 7, or multiply the first equation by 8 and the second equation by -7.

6. (1) You can solve both equations for y in terms of x. Then graph the resulting equations in the same window and locate the point of intersection.

(2) You can solve both equations for y in terms of x. Then make a calculator table of both equations and zoom in to find the x-value for which two y-values are the same.

(3) You can solve one equation for x in terms of y (or for y in terms of x) and then substitute the resulting expression for x (or for y) in the other equation.

(4) You can multiply both equations by numbers so that either the coefficients of x or the coefficients of y are opposites and then add the equations to eliminate a variable.

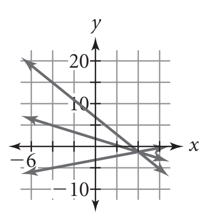
The solution is $(2, -2)$.

7. a. $(4, 2)$. Possible solution: Add the two equations to get $7x = 28$. Divide both sides by 7 to get $x = 4$. To find the value of y, substitute 4 for x in either equation. The result is $y = 2$.

b. $(3, -1)$. Possible solution: Subtract the second equation from the first to get $-2y = 2$. Divide both sides by -2 to get $y = -1$. To find the value of x, substitute -1 for y in either equation. The result is $x = 3$.

c. $(-3, -1)$. Possible solution: Subtract the second equation from the first to get $-3x = 9$. Divide both sides by -3 to get $x = -3$. To find the value of y, substitute -3 for x in either equation. The result is $y = -1$.

8.

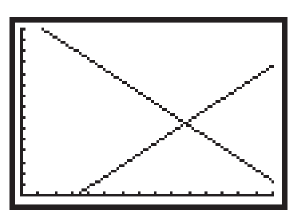


a. $y = -3 + 0.5x$ **b.** $y = 2 - 0.75x$

c. Adding the two original equations gives $4x + 2y = 14$. Solving for y gives $y = 7 - 2x$. The graph of this equation intersects the other two lines at their intersection point.

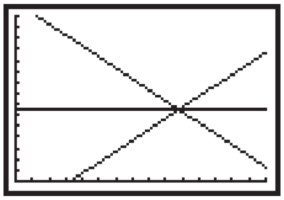
d. The solution of the system is also a solution of the sum of the equations.

9. a. $y = 163 - x$ and $y = -33 + x$

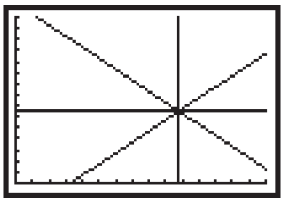


[0, 150, 10, 0, 150, 10]

b. Subtracting the second equation from the first gives $2y = 130$, so $y = 65$. The graph of this equation is shown as the horizontal line below.



c. Adding the equations gives $2x = 196$, so $x = 98$. The graph of this equation is shown as the vertical line below.



d. The four lines intersect at the same point, $(98, 65)$. The solution of the system is also a solution of the sum and difference of the equations.

10. Answers will vary. Substitute $(5, 2)$ for x and y in $4x + ay = b$ to get $20 + 2a = b$. Then find values of a and b that satisfy this equation. One possibility is $a = -3$ and $b = 14$, which gives the equation $4x - 3y = 14$.

11. a. The x-term can be eliminated either by multiplying the first equation by -3 or by multiplying the second equation by $-\frac{1}{3}$. If the first equation is multiplied by -3, the result will be $-6x + 15y = -36$.

b. Adding the equations $-6x + 15y = -36$ and $6x - 15y = 36$ gives $0 = 0$.

c. There are infinitely many solutions. (Any ordered pair that makes one of the equations in the original system true is a solution. These ordered pairs correspond to all points on the line with equation $2x - 5y = 12$.)

d. One equation is a multiple of the other.

12. a. First equation:

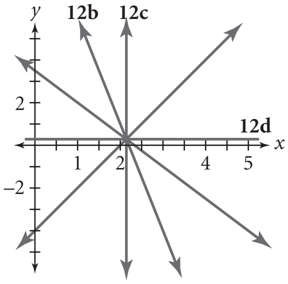
$3x + 2y = 7$

$2y = 7 - 3x$	Subtract $3x$ from both sides.
$y = 3.5 - 1.5x$	Divide both sides by 2.

Second equation:

$2x - y = 4$

$-y = 4 - 2x$	Subtract $2x$ from both sides.
$y = -4 + 2x$	Multiply both sides by -1.



b. The sum of the two original equations is $5x + y = 11$. To solve this equation for y, subtract $5x$ from both sides to obtain $y = 11 - 5x$. This line passes through the point where the two original equations intersect.

c. Multiplying the second original equation by 2 gives $4x - 2y = 8$. Adding this new equation to the first original equation gives $7x = 15$. Solving this equation gives $x = \frac{15}{7}$. This vertical line passes through the point where the two original equations intersect.

d. Multiplying the first original equation by 2 gives $6x + 4y = 14$. Multiplying the second original equation by -3 gives $-6x + 3y = -12$. Adding these two new equations gives $7y = 2$. Solving this equation gives $y = \frac{2}{7}$. This horizontal line passes through the point where the two original equations intersect.

e. Combining the x-value found in 12c and the y-value found in 12d, the solution of the system is $\left(\frac{15}{7}, \frac{2}{7}\right)$. This is the intersection point of all the lines in 12a–d.

f. Answers will vary. If two equations intersect in a point, any combination of multiples of the two equations intersects in the same point. That's why the elimination method works.

13. a. $\begin{cases} w + p = 10 \\ 3.25w + 10.50p = 61.50 \end{cases}$

b. $w = 6$, $p = 4$. They bought 6 wallet-size pictures and 4 portrait-size pictures.

14. a. Let c represent gallons burned in the city and h represent gallons burned on the highway. Then the system is

$\begin{cases} c + h = 11 \\ 17c + 25h = 220 \end{cases}$

b. $c = 6.875$, $h = 4.125$. She used 6.875 gallons in the city and 4.125 gallons on the highway.

c. $\frac{17 \text{ mi}}{\text{gal}} \cdot 6.875 \text{ gal} = 116.875 \approx 117$ city mi;

$\frac{25 \text{ mi}}{\text{gal}} \cdot 4.125 \text{ gal} = 103.125 \approx 103$ hwy mi

d. Check: $\begin{cases} 6.875 + 4.125 = 11 \\ 17(6.875) + 25(4.125) = 220 \\ 116.875 + 103.125 = 220 \end{cases}$

15. a. Possible answer: $\frac{5}{8}$ **b.** Possible answer: $\frac{3}{4}$

c. Possible answer: $-\frac{9}{40}$ **d.** Possible answer: $\frac{2}{3}$

e. Possible strategy: Rewrite the fractions with a common denominator. Then, write another fraction with the same denominator and with a numerator between the two numerators.

16. a. The rest station temperature is 14 degrees lower than the temperature at the start. The temperature falls 4 degrees for every 1000 feet, so the elevation must be $\frac{14}{4} \cdot 1000$, or 3500 feet higher than the start point. So, the elevation at the rest station is $4300 + 3500$, or 7800 feet.

The highest point is 7600 feet higher than the start, so the temperature must be $\frac{7600}{1000} \cdot 4$, or 30.4 degrees colder than at the start. The temperature at the highest point must be $78 - 30.4$, or 47.6 degrees.

b. The slope is $\frac{-4 \text{ degrees}}{1000 \text{ feet}}$, or -0.004 deg/ft. Using this slope and the point (4300, 78) gives the equation $T = 78 - 0.004(E - 4300)$. In slope-intercept form, this is $T = 95.2 - 0.004E$.

The slope is the rate of change in temperature for each increase of 1 foot in elevation. The y-intercept (or here the T-intercept) is the temperature that day at sea level (an elevation of 0 feet).

c. $95.2 - 0.004(20{,}320)$, or about 13.9°F

17. a. $y = -3 - 2(x - 5)$ **b.** $y = 7 + 2.5(x + 3)$

18. a. Walker A: $y = 0.5 + x$

Walker B: $y = 10.5$ when $x \leq 1$ and $y = 10.5 - 0.5(x - 1)$, or $y = 11 - 0.5x$, when $x > 1$

b. To find the time and place where the walkers meet, form systems of equations from the individual equations for the two walkers.

For $x \leq 1$, the system is

$$\begin{cases} y = 0.5 + x \\ y = 10.5 \end{cases}$$

The solution of this system is (10, 10.5), but this isn't a solution for the problem because it does not satisfy the restriction $x \leq 1$.

For $x > 1$, the system is

$$\begin{cases} y = 0.5 + x \\ y = 11 - 0.5x \end{cases}$$

The easiest way to solve this system is by the substitution method. Substituting $11 - 0.5x$ for y in the first equation gives $11 - 0.5x = 0.5 + x$, which leads to $x = 7$, which *does* satisfy the restriction $x > 1$. To find the corresponding value of y, substitute 7 for x in either of the original equations, giving $y = 7.5$. Therefore, the system has one solution, (7, 7.5). This means that the two walkers meet 7.5 ft from the sensor, when 7 s have passed.

c. Walker B is farther from the sensor than Walker A for all times up to, but not including, 7 s.

LESSON 5.4

EXERCISES

1. a. $\begin{cases} 2x + 1.5y = 12.75 \\ -3x + 4y = 9 \end{cases}$ **b.** $\begin{cases} \frac{1}{2}x = \frac{1}{2} \\ -x + 2y = 0 \end{cases}$

c. $\begin{cases} 2x + 3y = 1 \\ 2y = 0 \end{cases}$

2. a. $\begin{bmatrix} 1 & 4 & 3 \\ -1 & 2 & 9 \end{bmatrix}$ **b.** $\begin{bmatrix} 7 & -1 & 3 \\ 0.1 & -2.1 & 3 \end{bmatrix}$

c. $\begin{bmatrix} 1 & 1 & 3 \\ 1 & 1 & 6 \end{bmatrix}$

3. a. (8.5, 2.8) **b.** $\left(\frac{1}{2}, \frac{13}{16}\right)$ **c.** (0, 0)

4. Divide row 1 by 4.2. $\begin{bmatrix} 1 & 0 & 3 \\ 0 & -1 & 5.25 \end{bmatrix}$

Multiply row 2 by -1. $\begin{bmatrix} 1 & 0 & 3 \\ 0 & 1 & -5.25 \end{bmatrix}$

The solution is $(3, -5.25)$.

5. a. $\begin{cases} 3x + y = 7 \\ 2x + y = 21 \end{cases}$ **b.** $\begin{bmatrix} 3 & 1 & 7 \\ 2 & 1 & 21 \end{bmatrix}$

6.

Description	Matrix	System Equations
The matrix for $\begin{cases} 3x + 2y = 28.9 \\ 8x + 5y = 74.6 \end{cases}$	$\begin{bmatrix} 3 & 2 & 28.9 \\ 8 & 5 & 74.6 \end{bmatrix}$	
Add 8 times row 1 to -3 times row 2 and put the result in row 2.	$\begin{bmatrix} 3 & 2 & 28.9 \\ 0 & 1 & 7.4 \end{bmatrix}$	Row 3: $3x + 2y = 28.9$, $y = 7.4$
Add -2 times row 2 to row 1 and put the result in row 1.	$\begin{bmatrix} 3 & 0 & 14.1 \\ 0 & 1 & 7.4 \end{bmatrix}$	Row 4: $3x = 14.1$, $y = 7.4$
Divide row 1 by 3.	$\begin{bmatrix} 1 & 0 & 4.7 \\ 0 & 1 & 7.4 \end{bmatrix}$	Row 5: $x = 4.7$, $y = 7.4$

The solution is (4.7, 7.4).

7. a.

	Adults	Children	Total (kg)
Monday	40	15	10.8
Tuesday	35	22	12.29

b. Let x represent the average weight of chips an adult eats and y represent the average weight of chips a child eats. The system is

$$\begin{cases} 40x + 15y = 10.8 \\ 35x + 22y = 12.29 \end{cases}$$

c. $\begin{bmatrix} 40 & 15 & 10.8 \\ 35 & 22 & 12.29 \end{bmatrix}$

d. Solution steps will vary.

Add −35 times row 1 to 40 times row 2 and put the result in row 2. $\begin{bmatrix} 40 & 15 & 10.8 \\ 0 & 355 & 113.6 \end{bmatrix}$

Divide row 2 by 355. $\begin{bmatrix} 40 & 15 & 10.8 \\ 0 & 1 & 0.32 \end{bmatrix}$

Add −15 times row 2 to row 1. $\begin{bmatrix} 40 & 0 & 6 \\ 0 & 1 & 0.32 \end{bmatrix}$

Divide row 1 by 40. $\begin{bmatrix} 1 & 0 & 0.15 \\ 0 & 1 & 0.32 \end{bmatrix}$

e. Each adult ate an average of about 0.15 kg (150 g) of chips, and each child ate an average of 0.32 kg (320 g) of chips.

8.
```
[A]
      [[1 0 -1]
       [0 1 1 ]]
```

9. a. Let x represent the number of small trucks and y represent the number of large trucks. The system is $\begin{cases} 5x + 12y = 532 \\ 7x + 4y = 284 \end{cases}$.

b. $\begin{bmatrix} 5 & 12 & 532 \\ 7 & 4 & 284 \end{bmatrix}$

c. Solution steps will vary.

Add 7 times row 1 to −5 times row 2 and put the result in row 2. $\begin{bmatrix} 5 & 12 & 532 \\ 0 & 64 & 2304 \end{bmatrix}$

Divide row 2 by 64. $\begin{bmatrix} 5 & 12 & 532 \\ 0 & 1 & 36 \end{bmatrix}$

Subtract 12 times row 2 from row 1. $\begin{bmatrix} 5 & 0 & 100 \\ 0 & 1 & 36 \end{bmatrix}$

Divide row 1 by 5. $\begin{bmatrix} 1 & 0 & 20 \\ 0 & 1 & 36 \end{bmatrix}$

d. Zoe should order 20 small trucks and 36 large trucks.

10. a. The variable x represents the number of grams of flour X that are used in each loaf. The variable y represents the number of grams of flour Y that are used in each loaf. The first equation adds the amount of each kind of flour (in grams) to get the total amount of flour in the loaf. The second equation adds the amounts of calcium (in milligrams) contributed by each kind of flour to get the total amount of calcium.

b. $\begin{bmatrix} 1 & 1 & 300 \\ 0.12 & 0.04 & 30 \end{bmatrix}$

c. Solution steps will vary.

Add −0.12 times row 1 to row 2. $\begin{bmatrix} 1 & 1 & 300 \\ 0 & -0.08 & -6 \end{bmatrix}$

Divide row 2 by −0.08. $\begin{bmatrix} 1 & 1 & 300 \\ 0 & 1 & 75 \end{bmatrix}$

Subtract row 2 from row 1. $\begin{bmatrix} 1 & 0 & 225 \\ 0 & 1 & 75 \end{bmatrix}$

d. Will should mix 225 g of flour X with 75 g of flour Y.

11. a. $\begin{cases} m + t + w = 286 \\ m - t \quad = 7 \\ \quad t - w = 24 \end{cases}$

b. $\begin{bmatrix} 1 & 1 & 1 & 286 \\ 1 & -1 & 0 & 7 \\ 0 & 1 & -1 & 24 \end{bmatrix}$

The rows represent each equation. The columns represent the coefficients of each variable and the constants.

c. Solution steps will vary.

Subtract row 1 from row 2. $\begin{bmatrix} 1 & 1 & 1 & 286 \\ 0 & -2 & -1 & -279 \\ 0 & 1 & -1 & 24 \end{bmatrix}$

Divide row 2 by −2. $\begin{bmatrix} 1 & 1 & 1 & 286 \\ 0 & 1 & 0.5 & 139.5 \\ 0 & 1 & -1 & 24 \end{bmatrix}$

Subtract row 2 from row 3. $\begin{bmatrix} 1 & 1 & 1 & 286 \\ 0 & 1 & 0.5 & 139.5 \\ 0 & 0 & -1.5 & -115.5 \end{bmatrix}$

Divide row 3 by −1.5. $\begin{bmatrix} 1 & 1 & 1 & 286 \\ 0 & 1 & 0.5 & 139.5 \\ 0 & 0 & 1 & 77 \end{bmatrix}$

Subtract row 2 from row 1. $\begin{bmatrix} 1 & 0 & 0.5 & 146.5 \\ 0 & 1 & 0.5 & 139.5 \\ 0 & 0 & 1 & 77 \end{bmatrix}$

Add −0.5 times row 3 to row 1 and row 2. $\begin{bmatrix} 1 & 0 & 0 & 108 \\ 0 & 1 & 0 & 101 \\ 0 & 0 & 1 & 77 \end{bmatrix}$

d. They cycled 108 km on Monday, 101 km on Tuesday, and 77 km on Wednesday.

12. a. $\begin{bmatrix} 72 & 65 \\ 55 & 55 \\ 45 & 35 \end{bmatrix} - \begin{bmatrix} 31 & 28 \\ 26 & 24 \\ 21 & 16 \end{bmatrix} = \begin{bmatrix} 41 & 37 \\ 29 & 31 \\ 24 & 19 \end{bmatrix}$

b. If you are planning to be in the park for 3 days, then the 3-day ticket is a much better deal. The matrix showing the costs for three 1-day tickets is

$$3 \cdot \begin{bmatrix} 31 & 28 \\ 26 & 24 \\ 21 & 16 \end{bmatrix} = \begin{bmatrix} 93 & 84 \\ 78 & 72 \\ 21 & 48 \end{bmatrix}$$

c. The matrix showing the costs for two 1-day tickets is

$$2 \cdot \begin{bmatrix} 31 & 28 \\ 26 & 24 \\ 21 & 16 \end{bmatrix} = \begin{bmatrix} 62 & 56 \\ 52 & 48 \\ 42 & 32 \end{bmatrix}$$

These costs are less than the costs of the 3-day tickets, so if you are going for 2 days, you should buy two 1-day tickets.

13. a. 4 $\boxed{\text{ENTER}}$, Ans − 0.5, $\boxed{\text{ENTER}}$, $\boxed{\text{ENTER}}$, . . .

b. −3 $\boxed{\text{ENTER}}$, Ans + 2, $\boxed{\text{ENTER}}$, $\boxed{\text{ENTER}}$, . . .

c. 0.5 $\boxed{\text{ENTER}}$, Ans − 1, $\boxed{\text{ENTER}}$, $\boxed{\text{ENTER}}$, . . .

d. 0 $\boxed{\text{ENTER}}$, Ans + 1, $\boxed{\text{ENTER}}$, $\boxed{\text{ENTER}}$, . . .

14. a. The slope is 0.75, which is the cost per drink once you've bought the mug.

b. $y = 49.75 + 0.75(x - 33)$

c. $y = 25 + 0.75x$. The y-intercept is the cost of buying the mug.

15. Represent the system with a column matrix.

$$\begin{bmatrix} 1 & 3 \\ -2 & 1 \\ 3 & 23 \end{bmatrix}$$

Biancheng: Multiply the left column by 3 (the top number in the right column).

$3(1) \rightarrow 3$
$3(-2) \rightarrow -6$
$3(3) \rightarrow 9$

Zhichu: Subtract the right column from the left column once.

$3 - 3 \rightarrow 0$
$-6 - 1 \rightarrow -7$
$9 - 23 \rightarrow -14$

Write a new equation and solve for y: $-7y = -14$, or $y = 2$.

Substitute and solve for x: $x - 2(2) = 3$, or $x = 7$.

LESSON 5.5

Exercises

1. a. Multiply by 4; $12 < 28$

b. Multiply by −3; $-15 \geq -36$

c. Add −10; $-14 \geq x - 10$

d. Subtract 8; $b - 5 > 7$

e. Divide by 3; $8d < 10\frac{2}{3}$

f. Divide by −3; $-8x \geq -10\frac{2}{3}$

2. a. Answers will vary, but the values must be > 8.

b. Answers will vary, but the values must be > -7.

c. Answers will vary, but the values must be < 7.92.

d. Answers will vary, but the values must be $< \frac{120}{13} = 9\frac{3}{13} \approx 9.2308$.

3. a. $x \leq -1$ **b.** $x > 0$ **c.** $x \geq -2$

d. $-2 < x < 1$ **e.** $0 < x \leq 2$

4. a. $3 > x$ **b.** $y \geq -2$ **c.** $z \leq 12$ **d.** $n \leq 7$

5. a. $y = \frac{5.2 - 3x}{4} = 1.3 - 0.75x$

b. $y = \frac{2x}{3} + 5$, or $\frac{2x + 15}{3}$

6. Solution steps may vary.

a.

$4.1 + 3.2x > 18$	Original inequality.
$3.2x > 13.9$	Subtract 4.1 from both sides.
$x > 4.34375 = \frac{139}{32}$	Divide both sides by 3.2.

b.

$7.2 - 2.1b < 4.4$	Original inequality.
$-2.1b < -2.8$	Subtract 7.2 from both sides.
$b > 1.\overline{3}$	Divide both sides by −2.1 and reverse the inequality symbol.

c.

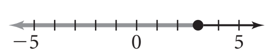
$7 - 2(x - 3) \geq 25$	Original inequality.
$7 - 2x + 6 \geq 25$	Apply the distributive property.
$-2x + 13 \geq 25$	Add.
$-2x \geq 12$	Subtract 13 from both sides.
$x \leq -6$	Divide both sides by −2 and reverse the inequality symbol.

d.

$11.5 + 4.5(x + 1.8) \leq x$	Original inequality.
$11.5 + 4.5x + 8.1 \leq x$	Apply the distributive property.
$19.6 + 4.5x \leq x$	Add.
$19.6 \leq -3.5x$	Subtract $4.5x$ from both sides.
$-5.6 \geq x$ or $x \leq -5.6$	Divide both sides by −3.5 and reverse the inequality symbol.

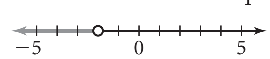
7. a.

$3x - 2 \leq 7$	Original inequality.
$3x \leq 9$	Add 2 to both sides.
$x \leq 3$	Divide both sides by 3.



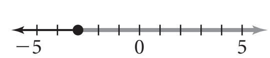
b.

$4 - x > 6$	Original inequality.
$-x > 2$	Subtract 4 from both sides.
$x < -2$	Divide both sides by −1 and reverse the inequality symbol.



c.

$3 + 2x \geq -3$	Original inequality.
$2x \geq -6$	Subtract 3 from both sides.
$x \geq -3$	Divide both sides by 2.

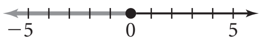


d. $10 \le 2(5 - 3x)$ Original inequality.

$10 \le 10 - 6x$ Apply the distributive property.

$0 \le -6x$ Subtract 10 from both sides.

$0 \ge x$, or $x \le 0$ Divide both sides by -6 and reverse the inequality symbol.



8. $50 + 7.5w > 120$; $w > 9.\overline{3}$. Ezra has been saving for at least 10 weeks.

9. a. Add 3 to both sides; $4 < 5$.

b. Divide both sides by 2 (or multiply by 0.5); $3 > 1$.

c. Multiply both sides by -3; $3 > -3$.

d. Multiply both sides by 2; $0 < 6$.

10. a. $-9 < 9$ is true.

b. $21 \ge 51$ is false.

c. $7 < 7$ is false.

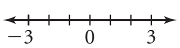
d. $24 \ge 18$ is true.

11. a. $2x - 3 > 5x - 3x + 3$ Original inequality.

$2x - 3 > 2x + 3$ Combine like terms.

$-3 > 3$ Subtract $2x$ from both sides.

Because $-3 > 3$ is never true, the inequality has no solutions. The graph would be an empty number line, with no values marked.

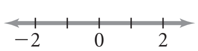


b. $-2.2(5x + 3) \ge -11x - 15$ Original inequality.

$-11x - 6.6 \ge -11x - 15$ Apply the distributive property.

$-6.6 \ge -15$ Add $11x$ to both sides.

Because $-6.6 \ge -15$ is always true, every number is a solution.



12. $2.834 - 0.002 \le x \le 2.834 + 0.002$

$2.832 \le x \le 2.836$ m

13. a. $d \le 30$, where d is the number of dollars spent on CDs

b. $h \ge 48$, where h is the height of a rider

c. $p \ge 3$, where p is the number of people in a carpool

d. $a \ge 17$, where a is the age of a person who will be admitted

14. a. When is the sports car 131 or more miles away from Flint?

b. $35 + 0.8x \ge 131$ Original inequality.

$35 + 0.8x - 35 \ge 131 - 35$ Subtract 35 from both sides of the inequality.

$0.8x \ge 96$ Evaluate.

$\frac{0.8x}{0.8} \ge \frac{96}{0.8}$ Divide both sides by 0.8.

$x \ge 120$ Evaluate.

The sports car is at least 131 miles from Flint when it has been traveling for at least 2 hours.

c. When is the minivan closer than the sports car to Flint?

d. $220 - 1.2x < 35 + 0.8x$ Original equation

$220 - 1.2x - 220 < 35 + 0.8x - 220$ Subtract 220 from both sides.

$-1.2x < -185 + 0.8x$ Evaluate.

$-1.2x - 0.8x < -185 + 0.8x - 0.8x$ Subtract $0.8x$ from both sides.

$-2.0x < -185$ Combine like terms.

$\frac{-2.0x}{-2.0} > \frac{-185}{-2.0}$ Divide both sides by -2.0, and reverse the inequality symbol.

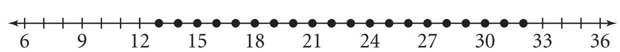
$x > 92.5$ Evaluate.

The minivan is closer than the sports car to Flint after 1 h 32 min 30 s.

15. $0 \le 8 - 0.25x < 5$ Original inequality.

$-8 \le -0.25x < -3$ Subtract 8 from all parts.

$32 \ge x > 12$ Divide by -0.25 and reverse the inequalities.



Erin woke up between 13 and 32 times, inclusive.

16. a. Multiply 12 by 3.2 to get 38.4. Subtract 38.4 from 72 to get 33.6.

b. Square 5 to get 25. Subtract 25 from 3 to get -22. Multiply -22 by 1.5 to get -33. Add -33 to 2 to get -31.

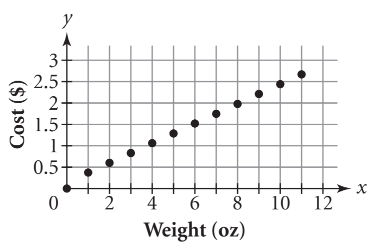
c. Divide 21 by 7 to get 3 and divide 6 by 2 to get 3. Subtract 3 from 3 to get 0.

17. a. 0.37 $\boxed{\text{ENTER}}$

Ans + 0.23 $\boxed{\text{ENTER}}$, $\boxed{\text{ENTER}}$, . . .

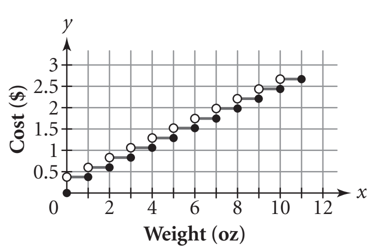
Weight (oz)	Rate ($)
1	0.37
2	0.60
3	0.83
4	1.06
5	1.29
6	1.52
7	1.75
8	1.98
9	2.21
10	2.44
11	2.67

b. **Postage Costs**



c. A line would mean that the cost would pass through each amount between the different increments. For example, if a package weighed 0.5 oz, you would pay $0.185. The line is not a useful way to show the costs because the cost increases discretely. Instead, you could draw segments for each whole ounce. Note the open and closed circles.

Postage Costs



d. Because the postal rates are for ounces or fractions of ounces, the price for a 10.5 oz parcel is the same as that for an 11 oz parcel, which the table in 17a shows to be $2.67.

Without this table or using the routine, this price can also be calculated from the given U.S. postal rates: The price will be $0.37 for the first ounce + $0.23 for each of the 10 additional ounces, which is $0.37 + 10($0.23) = $2.67.

18. a. $-2(x + 8) = (-2)(x) + (-2)(8) = -2x - 16$

b. $4(0.75 - y) = 4(0.75) + 4(-y) = 3 - 4y$

c. $-(z - 5) = -1(z - 5) = (-1)(z) + (-1)(-5)$
$= -z + 5$

LESSON 5.6

EXERCISES

1. a. iii **b.** ii **c.** i **d.** iv

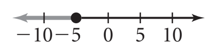
2. a.

$84x + 7y \geq 70$	Original inequality.
$7y \geq -84x + 70$	Add $-84x$ to both sides.
$y \geq -12x + 10$	Divide both sides by 7.

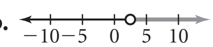
b.

$4.8x - 0.12y < 7.2$	Original inequality.
$-0.12y < -4.8x + 7.2$	Add $-4.8x$ to both sides.
$y > 40x - 60$	Divide both sides by -0.12 and reverse the inequality symbol.

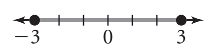
3. a.



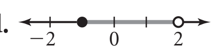
b.



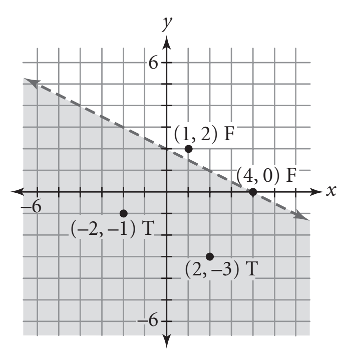
c.



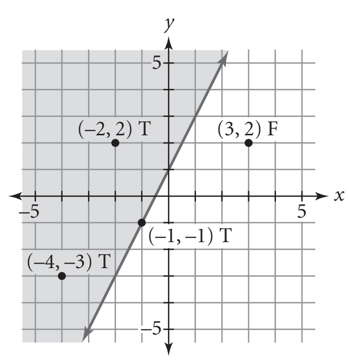
d.



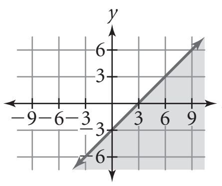
4. a.–c.



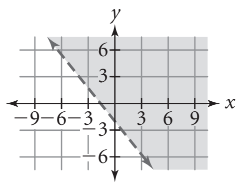
5. a.–c.



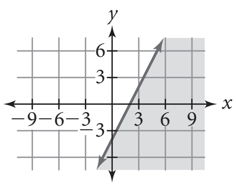
6. a.



b.



c.



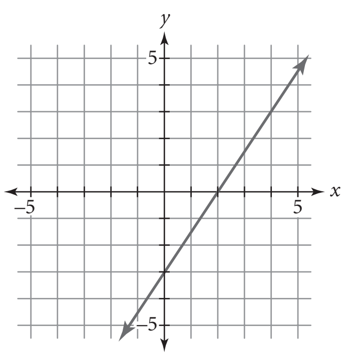
7. a. $y \leq 1 - 2x$ **b.** $y < -2 + \frac{2}{3}x$

c. $y > 1 - 0.5x$ **d.** $y \geq -2 + \frac{1}{3}x$

e. $y \leq 2$ **f.** $x < 2$

8. a.

$$
\begin{aligned}
3x - 2y &= 6 \\
3x - 2y - 3x &= 6 - 3x \\
-2y &= 6 - 3x \\
\frac{-2y}{-2} &= \frac{6 - 3x}{-2} \\
y &= -3 + 1.5x
\end{aligned}
$$



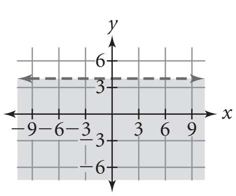
b. $(1, 3)$: $3(1) - 2(3) \leq 6 \rightarrow -3 \leq 6 \rightarrow$ True

$(1, -3)$: $3(1) - 2(-3) \leq 6 \rightarrow 9 \leq 6 \rightarrow$ False

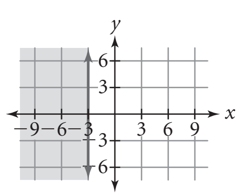
The point $(1, 3)$ makes the statement true. Because $(1, 3)$ is above the line, you should shade above the line.

c. If the coefficient of y is negative, then shade the side opposite of what is indicated by the inequality symbol.

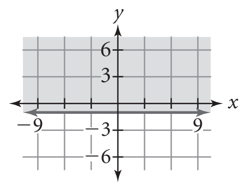
9. a.



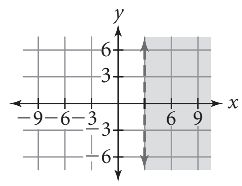
b.



c.



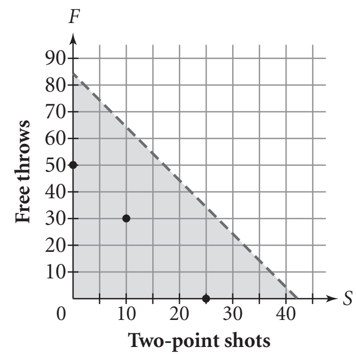
d.



10. a. $F + 2S < 84$

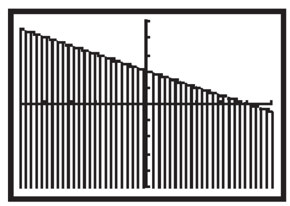
b. $F + 2S = 84$

c.

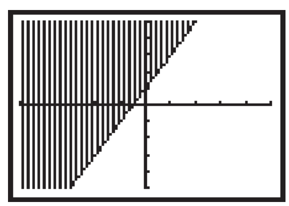


d. Answers will vary. One possible answer, indicated by dots on the graph, is $(0, 50)$, $(10, 30)$, and $(25, 0)$.

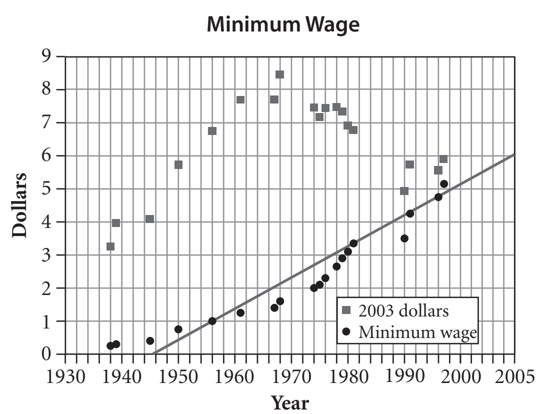
11.



$[-5, 5, 1, -5, 5, 1]$



12. a. and **d.**



b. The data for minimum wage is more linear than the data for equivalent dollars.

c. Using the Q-points (1956, 1.00) and (1981, 3.35), the equation is
$y = 3.35 + 0.094(x - 1981)$,
or $y = 1.00 + 0.094(x - 1956)$,
or $y = -182.864 + 0.094x$.

e. The minimum wage has increased 9¢ every year on average. The actual dollar value was highest in 1968 and has decreased almost every year since then.

13. a. About 27 mi/h

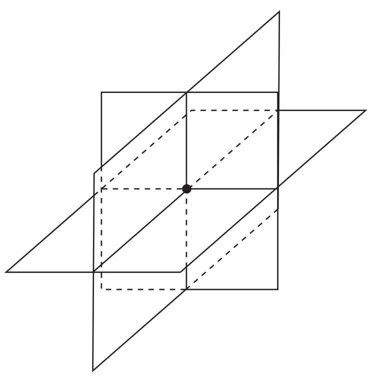
b. Possible explanation: Because $d = r \cdot t$, and the distance was the same for both Ellie and her grandmother, you can set the product of rate and time for Ellie equal to the product of rate and time for her grandmother. If you let r represent Ellie's grandmother's speed, then $2.5(65) = 6r$.

14. a. $y = \frac{7}{3}x - \frac{22}{3}$

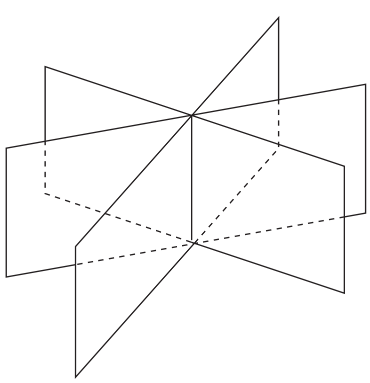
b. $y = -\frac{5}{4}x - 3$

Improving Your Visual Thinking Skills

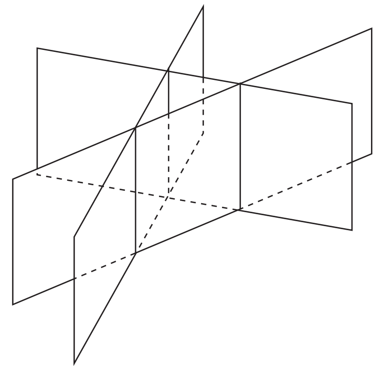
- Three planes intersect in only one point if each pair of planes intersects in a line and the three lines intersect in one point. Such a system has one solution.



- If a system has an infinite number of solutions, the three equations might represent the same plane, but they might also represent planes that intersect in a line.



- If a system has no solutions, two of the planes might be parallel. Or two of the planes might intersect in a line and the third plane might be parallel to the line of intersection of the first two planes.



Lesson 5.7

Exercises

1. a. iii **b.** i **c.** ii

2. a. Yes. (1, 2) satisfies both inequalities.

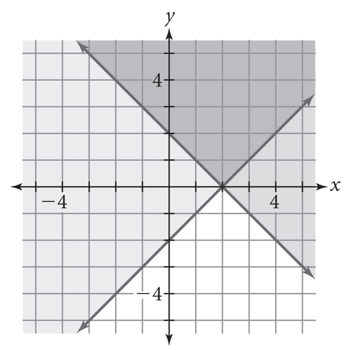
b. No. $2 > 3$ is not true, so the first inequality is not satisfied.

c. No. $\frac{4}{3} > \frac{4}{3}$ is not true, so neither inequality is satisfied.

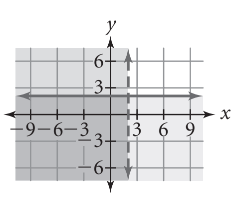
d. No. Because both $-3 > 5$ and $-3 > 2 - \frac{1}{2}(5)$ are false, neither inequality is satisfied.

3. a. $y \geq -x + 2$; $y \geq x - 2$

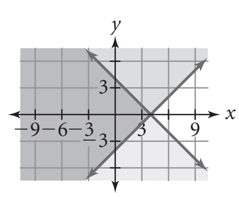
b.



4. a.



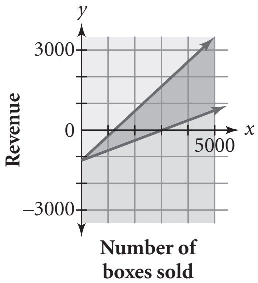
b.



5. $\begin{cases} y > 2 - x \\ y < 2 \\ x < 3 \end{cases}$

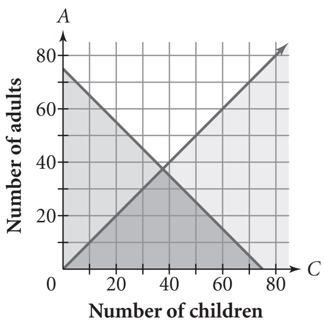
6. a. The three inequalities are $y \geq -1250 + 0.40x$, $y \leq -1250 + 1.00x$, and $x \geq 0$.

b.

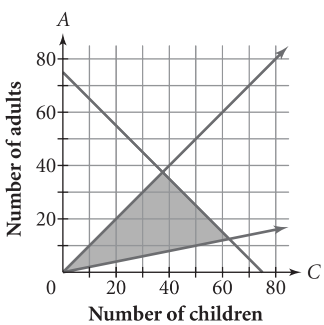


7. a. $\begin{cases} A \leq C \\ A + C \leq 75 \\ A \geq 0 \\ C \geq 0 \end{cases}$

b. All the points in the dark-shaded triangular region satisfy the system of inequalities. The point (50, 10) represents the situation in which 50 children escort 10 adults.



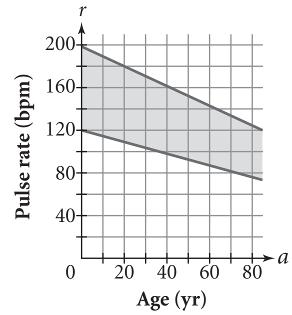
c. Answers will vary. It is possible to have all children and no adults at the restaurant. One possible additional constraint is that there must be at least one adult per five children, or $A \geq \frac{1}{5}C$. The solution for this set of constraints is shown below.



8. a. $r = 220 - a$, where a represents age in years and r represents the heart rate in beats per minute.

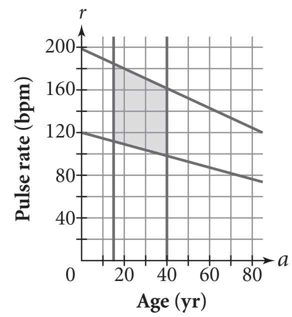
b. $\begin{cases} r \leq 0.90(220 - a) \\ r \geq 0.55(220 - a) \end{cases}$ or $\begin{cases} r \leq 198 - 0.09a \\ r \geq 121 - 0.55a \end{cases}$

c.



d. $a \geq 14$ and $a \leq 40$

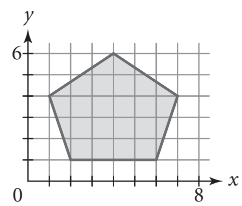
e.



9. $x \geq 3$ and $y \geq -2 + \frac{1}{2}x$

10. AB: $y \leq \frac{2}{3}x + \frac{5}{3}$; BC: $y \leq -\frac{3}{5}x + \frac{59}{5}$; AC: $y \geq \frac{1}{11}x + \frac{31}{11}$

11. The region is a pentagon.



12. Region 1: $\begin{cases} y \geq 3 \\ y \geq x - 2 \\ y \leq \frac{1}{3}x + \frac{8}{3} \end{cases}$ Region 2: $\begin{cases} y \leq 3 \\ y \leq x - 2 \\ y \geq \frac{1}{3}x \end{cases}$

13. a. \$713.15

b. \$957.80

14. a. 4

b. 10

c. $\frac{10[(3x + 12) \div 5 - 1.4] - 10}{6}$, which simplifies to x.

15. a. $x = 6$, $y = 21$

b. $x = -2$, $y = -1$

16. Sample solution: Let p represent the concentration of acid in the pickling vinegar.

$$8(0.05) + 20p = 28(0.15)$$
$$p = 0.19$$

The acid concentration of the pickling vinegar is 19%.

IMPROVING YOUR REASONING SKILLS

Crows	Cries
9	729
99	970,299
999	997,002,999
9,999	999,700,029,999
99,999	999,970,000,299,999

The TI-84 Plus calculator begins rounding at 9,999 crows.

CHAPTER 5 Review

EXERCISES

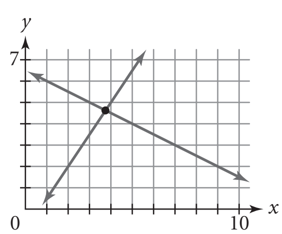
1. Line a: $y = 1 - x$; line b: $y = 3 + \frac{5}{2}x$. To find the intersection point, you can solve the system using substitution:

$y = 3 + \frac{5}{2}x$	Original equation for line b.
$1 - x = 3 + \frac{5}{2}x$	Substitute $1 - x$ (from the line a equation) for y.
$-2 - x = \frac{5}{2}x$	Subtract 3 from both sides.
$-2 = \frac{7}{2}x$	Add x to both sides.
$-\frac{4}{7} = x$	Multiply both sides by $\frac{2}{7}$.

Using the equation for line a, $y = 1 - \left(-\frac{4}{7}\right) = \frac{11}{7}$. So, the point of intersection is $\left(-\frac{4}{7}, \frac{11}{7}\right)$.

2. One way to find the point of intersection is to solve the system by elimination. Adding the equations gives $4x = 16$, so $x = 4$. Substituting 4 for x in either equation gives $y = 1$. So, the point of intersection is $(4, 1)$. Check: $3(4) - 2(1) = 10$, $(4) + 2(1) = 6$.

3. The point of intersection is (3.75, 4.625).



4. Solution steps may vary.

$16 + 4.3(x - 5) = -7 + 4.2x$	Set the right sides of the equations equal to each other.
$16 + 4.3x - 21.5 = -7 + 4.2x$	Apply the distributive property.
$-5.5 + 4.3x = -7 + 4.2x$	Subtract.
$0.1x = -1.5$	Add $-4.2x$ and 5.5 to both sides.
$x = -15$	Divide both sides by 0.1.
$y = -7 + 4.2(-15)$	Substitute -15 for x in the second equation and find y.
$y = -70$	Multiply and add.

The solution is $x = -15$ and $y = -70$.

5. **a.** The lines have the same slope but different y-intercepts (the lines are parallel).

b. The slopes are the same and the intercepts are the same (the equations represent the same line).

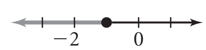
c. The lines have different slopes (the lines intersect in a single point).

6. **a.** $x > -1$

b. $x < 2$

c. $-2 \leq x < 1$

7. $x \leq -1$



8. $\begin{cases} y \leq x + 4 \\ y \leq -1.25x + 8.5 \\ y \geq 1 \end{cases}$

9. **a.** $\dfrac{15 \text{ m} \times 12 \text{ m}}{18 \text{ min}} = 10 \text{ m}^2/\text{min}$;

$\dfrac{20 \text{ m} \times 14 \text{ m}}{40 \text{ min}} = 7 \text{ m}^2/\text{min}$

b. No. The area of Mr. Fleming's lawn is 396 m^2. Using his plan, Harold will cut only $10 \text{ m}^2/\text{min} \cdot 10 \text{ min} + 7 \text{ m}^2/\text{min} \cdot 8 \text{ min}$, or 156 m^2.

c. $10h + 7l = 396$

d. $\dfrac{0.6 \text{ L}}{18 \text{ min}} = \dfrac{1}{30}$ L/min;

$\dfrac{0.6 \text{ L}}{40 \text{ min}} = \dfrac{3}{200}$ L/min

e. $\dfrac{h}{30} + \dfrac{3l}{200} = 1.2$

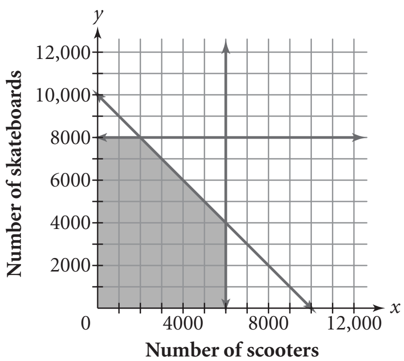
f. $l = 14.4$ min, $h = 29.52$ min; if he cuts for 29.52 min at the higher speed and 14.4 min at the lower speed, he will finish Mr. Fleming's lawn and use one full tank of gas.

10. $\begin{bmatrix} 1 & 0 & -3 \\ 0 & 1 & -8 \end{bmatrix}$

TAKE ANOTHER LOOK

If x is the number of scooters and y is the number of skateboards, then the following system describes the constraints:

$$\begin{cases} x \leq 6000 \\ y \leq 8000 \\ x + y \leq 10{,}000 \\ x \geq 0 \\ y \geq 0 \end{cases}$$



Profit: $15x + 10y$

Substituting the coordinates (6000, 4000) gives $130,000, which is the greatest possible profit.

CHAPTER 6

LESSON 6.1

EXERCISES

1. a. Starting value: 16; multiplier: 1.25; 7th term: 61.035

   b. Starting value: 27; multiplier: $\frac{2}{3}$, or $0.\overline{6}$; 7th term: $2.\overline{370}$, or $\frac{64}{27}$

2. {0, 100} $\boxed{\text{ENTER}}$, {Ans(1) + 1, Ans(2) $\cdot$ -1.6} $\boxed{\text{ENTER}}$, $\boxed{\text{ENTER}}$, ... The first six terms are 100, -160, 256, -409.6, 655.36, -1048.576.

3. a. 8% increase: $\frac{108}{100}$; $1 + 0.08$

   b. 11% decrease: $\frac{89}{100}$; $1 - 0.11$

   c. 12.5% growth: $\frac{1125}{1000}$ or $\frac{112.5}{100}$; $1 + 0.125$

   d. $6\frac{1}{4}$% loss: $\frac{9{,}375}{10{,}000}$ or $\frac{93.75}{100}$; $1 - 0.0625$

   e. x% increase: $\frac{100 + x}{100}$; $1 + \frac{x}{100}$

   f. y% decrease: $\frac{100 - y}{100}$; $1 - \frac{y}{100}$

4. a. $75(1 + 0.02)$, or $75(1.02)$

   b. $1000(1 - 0.18)$, or $1000(0.82)$

   c. $P(1 + r)$

   d. $75 - 75 \cdot 0.02$

   e. $80 - 80 \cdot 0.24$

   f. $A - A \cdot r$

5. {0, 32} $\boxed{\text{ENTER}}$, {Ans(1) + 1, Ans(2) $\cdot$ 0.75} $\boxed{\text{ENTER}}$, $\boxed{\text{ENTER}}$, ... Stage 2 has a shaded area of 18 square units; Stage 5 has a shaded area of 7.59375 square units.

6. a. {0, 20000} $\boxed{\text{ENTER}}$, {Ans(1) + 1, Ans(2) $\cdot$ (1 − 0.04)} $\boxed{\text{ENTER}}$, $\boxed{\text{ENTER}}$, . . .

   b. The 5th term, $16,986.93, represents the selling price of the car after four price reductions.

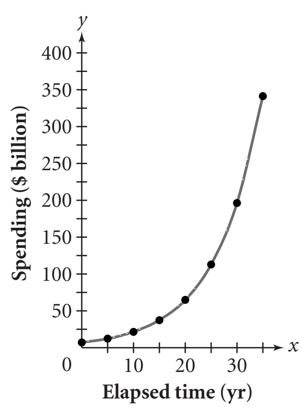
   c. 17 weeks (the18th term of the sequence)

7. a. {0, 7.1} $\boxed{\text{ENTER}}$, {Ans(1) + 1, Ans(2) $\cdot$ (1 + 0.117)} $\boxed{\text{ENTER}}$, $\boxed{\text{ENTER}}$, . . .

   b.

Year	Elapsed time (yr), x	Spending ($ billion), y
1970	0	7.1
1975	5	12.3
1980	10	21.5
1985	15	37.3
1990	20	64.9
1995	25	112.9
2000	30	196.3
2005	35	341.3

   c.



   d. Answers will vary. The graph implies a smooth, ever-increasing amount of Medicare spending, which is probably not realistic.

8. a. {0, 115} $\boxed{\text{ENTER}}$, {Ans(1) + 1, Ans(2) $\cdot$ (1 − 0.03)} $\boxed{\text{ENTER}}$, $\boxed{\text{ENTER}}$, . . .

   b. 12 minutes

9. a. 2 m $\cdot$ 0.85 = 1.7 m

   b. {0, 2} $\boxed{\text{ENTER}}$, {Ans(1) + 1, Ans(2) $\cdot$ 0.85} $\boxed{\text{ENTER}}$, $\boxed{\text{ENTER}}$, . . .